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Cooperative State Research, Education, and Extension Service

Competitive Programs

National Research Initiative Competitive Grants Program

Annual Report
Fiscal Year 2003

"Knowledge for Tomorrow's Solutions"

http://www.csrees.usda.gov/funding/nri/nri.html
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Materials Available on the Internet

This annual report and other NRI materials, such as Abstracts of Funded Research and the 2003 Program Description, are available on the NRI home page at *http://www.csrees.usda.gov/funding/nri/nri.html*.

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Message from the Competitive Programs Science Advisor:

Dear Colleagues:

Agriculture is the most expansive, complex, and successful of all human undertakings. In no small part, the strength and security of the United States was founded and continues to rest on the country's collective ability to reliably produce a robust, high quality supply of food, fiber, and other renewable resources while at the same time enhancing the future of rural communities and the quality of our environment. Over the past 100 years our nation has created a vigorous research and higher-educational enterprise, and as a society we have enjoyed the many fruits of that investment. In support of this effort, the National Research Initiative (NRI) has rightly been called the premier competitive research program of its kind.

In good times and bad, our nation will face any number of competing priorities, but our future prosperity depends largely on a continued investment in science, engineering, and education. The combined enterprise of science and education provides a positive foundation for the future and the partnership between the universities and the USDA meets that challenge by generating new knowledge, communicating that knowledge to those who need it, and educating the next generation of agricultural research scientists.

Like other USDA programs, NRI supports the agricultural community in addressing the ever-evolving demand of being a positive economic, social, and environmental force both nationally and internationally. To allow for continual gains in food and fiber production, environmental quality, public health, and community well-being, this requires new basic knowledge as well as new applications of current knowledge. Because of the close association with universities, the Competitive Programs unit in general, and the NRI in particular, are well positioned to provide leadership within the USDA by fostering research programs that are anticipatory, strategic, flexible, collaborative, cost-effective, and accountable both politically and to a broader client base.

"Quality" and "value" are terms commonly used to rank all types of activities, and federal education and research grant programs are no exception. As has been done with other publicly funding functions, science is entering a time of greater political accountability. In this time of performance and results planning and reporting, the nation's scientific leaders are looking for ways to be more responsive while at the same time mindful that programmatic and funding decisions must be scientifically sound, relevant, and responsive to the public need. Central to this notion is that performance planning should be based on analytical assessments of the importance of issues and problems, and that this is then translated into programmatic priorities. Such priority-setting activities must also be based on ongoing assessment of where science is going and what the active scientific research community thinks will be feasible. In all areas, the NRI is appropriately adapting to these new realities.

Public attitudes, policy-making, and the scientific/educational enterprises that these support are dynamic, not static processes that require constant attention. The pace of

change in publicly supported research and technology funding has quickened. Responding to recommendations provided by recent National Research Council reviews and Congressional directives, the NRI successfully enhanced its planning efforts toward the goal of meeting the knowledge-based needs of the nation through the strategic deployment of limited resources.

A number of important advancements have recently taken place at the NRI which reflect ongoing efforts to enhance the program's effectiveness. In association with a budget increase, Congressional approval was given to allow up to 20% of the NRI's budget to be directed at integrated efforts that combine research, education, and extension activities. The NRI is now well-structured to respond in a more dynamic and responsive fashion, while at the same time respecting the inherent value of all the other USDA programs that provide funding support for agriculture research and education by other mechanisms. Importantly, the NRI now has a full complement of programmatic tools that can be deployed in a fashion that most appropriately addresses the agricultural knowledge, education, and production needs of the country.

With input from all interested parties, the NRI is also moving to take a more active role in crafting the research portfolio of its various programs. The intent is to strike an appropriate balance (as dictated by the issues, topics, and knowledge gaps) across basic and applied research efforts. In the longer term this will help accomplish pre-defined Departmental and Agency strategic goals by setting out specific topics viewed as having national priority for funding. The objective is to encourage scientists to focus their attention on specific topics, while at the same time remaining receptive to novel ideas and topics not yet anticipated or recognized.

While individual investigator-originated hypothesis-driven basic and applied research will remain the fundamental core of the NRI funding portfolio, in 2003 a new funding mechanism termed Cooperative Agricultural Project (CAP) was initiated in Animal Biosecurity Program. The CAP is designed to foster active multi-disciplinary engagement of basic and applied scientists in an effort to accelerate progress on a focused topic of national importance while allowing maximum programmatic and budget flexibility.

The following report provides an overview of the vital statistics of the NRI during the Fiscal Year 2003 funding cycle. Also included in this report are selected grants that successfully competed for funding via the peer review process, and which persuasively illustrate the high quality and importance of the research supported by the NRI. As a new addition to this year's report, research efforts that were completed during the past year were selected to recognize the remarkable success of NRI-supported scientists in advancing our understanding of fundamental biological processes, as well as in addressing practical problems of agricultural importance to our nation.

One of the most rewarding aspects of serving as Competitive Programs Science Advisor is the opportunity to interact with the various stakeholder groups and scientific societies involved in fostering and promoting excellence in agriculture, food science, and

education. It should be noted that the staff, national program leaders, and administrators of the NRI do an excellent job in making remarkably good use of the limited funding that is made available to the program, which by all measures is sufficient to support only a relatively small fraction of the research judged to be highly worthy of support. I would particularly like to recognize the many scientists who fundamentally enable the NRI to accomplish its mission by contributing through their research as well as in the peer review and program planning processes.

In summary, I am pleased to report without reservation that much has been and is currently being accomplished by the NRI (and by the USDA in general). However, the fundamental need and value of advancing the capacity as well as protecting the nation's agricultural enterprise through additional research, education, and extension activities are often underestimated. The considerable economic impacts of diseases in plants and animals that occurred during the past year more than adequately illustrate the need to continue and enhance the capacities of the NRI.

Brad Fenwick, Ph.D.
Science Advisor
Competitive Programs

The National Research Initiative: An Overview

USDA's National Research Initiative was established in 1991 in response to recommendations outlined in *Investing in Research: A Proposal to Strengthen the Agricultural, Food and Environmental System,* a 1989 report by the National Research Council's (NRC) Board on Agriculture. This publication called for increased funding of high priority research, funded by USDA through a competitive peer-review process, directed at:

- Increasing the competitiveness of U.S. agriculture.
- Improving human health and well-being through an abundant, safe, and high-quality food supply.
- Sustaining the quality and productivity of the natural resources upon which agriculture depends.

Continued interest in and support of the NRI is reflected in two subsequent NRC reports, *Investing in the National Research Initiative: An Update of the Competitive Grants Program of the U.S. Department of Agriculture,* published in 1994, and *National Research Initiative: A Vital Competitive Grants Program in Food, Fiber, and Natural-Resources Research,* published in 2000.

Competitive Review Process

The NRI competitive review process encourages innovative ideas that are likely to open fundamentally new research approaches to enhancing agriculture, food, forestry, and the environment. A proven mechanism for stimulating new scientific research, the competitive review process increases the likelihood that investigations addressing important, relevant topics using well-designed and well-organized experimental plans will be funded. Each year, panels of scientific peers meet to evaluate and recommend proposals based on scientific merit, investigator qualifications, and relevance of the proposed research to U.S. agriculture.

At least 10 percent of NRI funds support Agricultural Research Enhancement Awards. These awards enhance the U.S. agricultural research system through funding of postdoctoral fellowships and research by new investigators as well as through Strengthening Awards.

Strengthening Awards include Research Career Enhancement Awards, Equipment Grants, Seed Grants, and Strengthening Standard Research Projects. These grants fund researchers at small and mid-sized institutions ($\leq$ 15,000 total enrollment) with limited institutional success or in states and other entities that are part of the Experimental Program for Stimulating Competitive Research (EPSCoR).

The NRI encourages multi-disciplinary research, which is needed to solve complex problems, and seeks to initiate research in new areas of science and engineering that are relevant to agriculture, food, forestry, and the environment. The NRI also supports scientific conferences to facilitate the exchange of information necessary to achieve the

most rapid advances in these areas. Both mission-linked research and fundamental research are supported by the NRI. Mission-linked research targets specific problems, needs, or opportunities. Fundamental research – the quest for new knowledge about agriculturally important organisms, processes, systems, or products – opens new directions for mission-linked research. Both mission-linked research and fundamental research are essential to the sustainability of agriculture.

Identification of Research Priorities

Setting research priorities is an important means of facilitating the scientific and technological advances needed to meet the challenges facing U.S. agriculture. Congress sets the basic budgetary framework for the NRI. In the legislation that authorized the establishment of the NRI, Congress defined high-priority research as basic and applied research that focuses on both national and regional research needs (and methods for technology transfer). The authorizing legislation requires that, as appropriate, grants be consistent with the development of systems of sustainable agriculture. Congress further has specified that no less than 30 percent of funds be used to support multi-disciplinary team research, no less than 40 percent be used for mission-linked research, and no less than 10 percent be used to strengthen the research capacity of individuals and institutions. Members of Congress also make recommendations for the scientific and programmatic administration of the NRI through appropriation language and through their questions and comments during Congressional budgetary hearings.

Input into the NRI priority-setting process is sought from a wide range of NRI customers, stakeholders and end-users. The scientific community provides direction for the NRI through the research proposals it submits each year, as well as through the research proposal evaluations and funding recommendations of individual scientific peer-review panels. In addition, the NRI receives comments on its programs from academic administrators, other staff members, and scientists from universities; the Experiment Station Committee on Policy; and the research administrators of the land-grant institutions.

NRI scientific staff members play an important role in providing continuity of programmatic leadership and scientific administration from year to year. Staff members attend scientific and professional meetings to stay current on scientific trends that need to be reflected in the *NRI Program Description* and in the coordination of priority setting with other federal agencies. NRI staff also participate in meetings with representatives of key commodity groups and other user groups to discuss these stakeholders' current research priorities, to learn ways the NRI can assist in meeting their needs, and to solicit comments and suggestions on NRI research priorities.

Input from several coalitions has proved to be an important source of information. NRI staff members meet with groups such as the Institute of Food Technologists, CoFARM, C-FARE, and the Animal Agriculture Coalition to gain a broad perspective on current research needs and priorities.

In Competitive Programs, the Science Advisor, Deputy Administrator and NRI scientific

staff are responsible for assimilating the input of diverse stakeholder groups into a program description that will solicit the highest-quality proposals to meet the needs of U.S. agriculture, food, forestry and the environment. The NRI research areas, which are evaluated and updated each year, are listed in the *NRI Program Description* issued annually. The *NRI Program Description* is accessible to the public – both in printed form and on the Internet via the NRI home page (*http://www.csrees.usda.gov/funding/nri/nri.html*).

Request for Applications

In 2003 the NRI published a standard Requests for Applications (RFA) and several supplemental RFAs for the NRI Integrated Program.

Standard RFA

The standard RFA states the purpose of the NRI is to support high priority fundamental and mission-linked research of importance in the biological, environmental, physical, and social sciences relevant to agriculture, food, and the environment. For this purpose, the following definitions apply:

- **Fundamental Research:** Research that tests scientific hypotheses and provides basic knowledge which allows advances in applied research and from which major conceptual breakthroughs are expected to occur.

- **Mission-linked Research:** Research on specifically identified agricultural problems which, through a continuum of efforts, provides information and technology that may be transferred to users and may relate to a product, practice, or process.

- **Multidisciplinary Research:** Research in which investigators from two or more disciplines are collaborating closely. These collaborations, where appropriate, may integrate the biological, physical, chemical or social sciences.

Because of the complexity of many agricultural problems, research on those problems is often best accomplished using a multidisciplinary approach. The NRI recognizes the need for this approach and encourages multidisciplinary research.

The NRI includes a broad portfolio of programs that address critical agricultural research needs. The NRI has also identified three *strategic issues* where an investment in science will accelerate the generation of critically needed agricultural solutions. The issues are: ***Agricultural Security and Safety Through Functional Genomics***, ***New and Re-Emerging Disease and Pest Threats,*** and ***Global Change***. All of these high priority issues cut across research programs in the NRI divisions and are directly applicable to a broad agricultural and consumer spectrum. Expectations are that these strategic issues will exist within the NRI for a minimum of 3-5 years. Dependent on funding, additional strategic issues may be possible in future years.

The concept of strategic issues was recommended in the 2000 review of the NRI conducted by the National Academy of Sciences, National Research Council (*National Research Initiative: A Vital Competitive Grants Program in Food, Fiber, and Natural-Resources Research*). It has been echoed by other stakeholders including the Coalition on Funding Agricultural Research Missions (CoFARM), the Council for Agricultural Science and Technology (CAST), the Federation of American Societies for Experimental Biology (FASEB), the State Agricultural Experiment Station Directors, and others. Results from research in these areas will have a positive impact economically and on the quality of life for producers, processors and consumers.

Supplemental RFA for Integrated Programs

The supplemental RFA dstated the purpose of NRI Integrated Programsto support research, extension and education grants that address critical emerging U.S. agricultural and rural issues. In awarding these grants, priority was given to projects that are: (1) multistate, multi-institutional, or multidisciplinary; or (2) projects that integrate agricultural research, extension, and education. Integrated projects hold the greatest potential to produce and transfer knowledge directly to end users, while providing for educational opportunities to assure agricultural expertise in future generations.

In FY 2003, the NRI Integrated Program supported the following five program areas: (1) Functional Genomics of Agriculturally Important Organisms, (2) Air Quality, (3) Human Nutrition and Obesity, (4) Animal and Plant Biosecurity; and (5) National Training Program for Agricultural Homeland Security.

Integrated Programs in the NRI are unique in their emphasis on integration of research with extension and/or and education, and their goal of supporting relatively large projects that provide more intensive support to the research, extension, and education system.

Section 737 of the General Provisions of the Consolidated Appropriations Resolution, 2003 (Division A of Pub. L. 108-7) dprovided CSREES with the authority to use up to twenty percent of the amount made available in the Act for the National Research Initiative Competitive Grants Program (NRI), to carry out a competitive grants program under the same terms and conditions as those provided in Section 401 of the Agricultural Research, Extension, and Education Reform Act of 1998 (AREERA) (7 U.S.C. 7621). Section 401 of AREERA established in the Treasury of the United States an account and authorized the Secretary of Agriculture to establish a research, extension, and education competitive grants program to address critical emerging U.S. agricultural and rural issues related to future food production; environmental quality and natural resource management; farm income; or rural, economic and business and community development policy.

Program Implementation

The *NRI Program Description* is distributed widely within the scientific community and among other interested groups. The FY 2003 *NRI Program Description and Guidelines*

for Proposal Preparation, published in the *Federal Register*, identified 33 research programs within the following six major research areas:

- Natural Resources and the Environment
- Nutrition, Food Quality, and Health
- Plant Systems
- Animal Systems
- Markets, Trade, and Policy
- New Products and Processes

A total of 4,256 research proposals were considered for funding in FY 2003. Thirty-nine peer panels reviewed and ranked the proposals, evaluating them on scientific merit, the qualifications of proposed project personnel, the adequacy of the proposed facilities, and the relevance of the proposed project to long-range improvements in – and the sustainability of – U.S. agriculture.

Each peer panel was composed of individuals with the expertise required to review each proposal thoroughly and fairly. Proposals for Postdoctoral Fellowships, New Investigator Awards, Strengthening Standard Research Projects, Research Career Enhancement Awards, Equipment Grants, and Seed Grants were reviewed within the specified research program.

Criteria for the selection of panel members included knowledge of the relevant scientific discipline, educational background, experience, and professional stature within the scientific community. The membership of each panel was carefully balanced to reflect diversity in geographical region, type of institution, type of position, and gender and minority status (see Table 1).

Additional expertise was brought to proposal evaluation by a number of scientists and other experts representing a wide variety of fields, who conducted *ad hoc* reviews. These reviews provided the additional expertise that made it possible to select the highest quality, most meritorious proposals for funding.

More than 9,000 scientists contributed their time and expertise to the NRI proposal evaluation process in FY 2003. Participation in the panels and in writing *ad hoc* reviews provided many individuals the opportunity to gain experience in the review process and to become more familiar with the nature of the science supported by the NRI. The pool of *ad hoc* reviewers also provided a resource from which future panel members may be selected.

At the conclusion of the review process, a summary of the panel evaluation and the written reviews were forwarded to the submitting investigators, providing them with critical assessments of their proposed research by recognized leaders in the appropriate fields. The reviewers' comments and suggestions also were important for purposes of refining the proposals for future resubmission.

Continuing a practice begun in 1993, non-technical summaries describing each research

project funded in FY 2003 will be published as *Abstracts of Funded Research* and posted on the Internet on the NRI home page (*http://www.csrees.usda.gov/funding/nri/nri.html*).

Grantsmanship Workshops

NRI program staff conducted an annual workshop in FY 2003 to increase applicants' and administrators' understanding of the philosophy, directives, and procedures of the NRI competitive review process. In FY 2003, CSREES staff held a well–attended grant-writing workshopworkshops in Minnesota hosted by the University of Minnesota. . The workshops focused on Cooperative State Research, Education and Extension Funding opportunities in competitive research and integrated programs. Breakout sessions include guidelines for preparing proposals, individual program descriptions, and recent funding statistics. In addition, the NRI staff conducted individualized workshops or made presentations at national meetings of scientific and/or professional societies, for regional research groups and other audiences from EPSCoR institutions and 1890 Land Grant Institutions.

Funded Research

In FY 2003, a total of 4,256 proposals were submitted to the NRI, requesting a total of $1,666,889,684. Awards totaling $131,227,672 were made to the 664 highest-ranked proposals (see Table 2).

The success rate (in terms of number of proposals funded and excluding conferences, supplements, and continuing increments of the same grant) was 16 percent. The average grant award for new standard research projects (excluding Research Career Enhancement Awards, Equipment Grants, Seed Grants, conferences, continuing increments, and supplements) in FY 2003 was $188,305 for 2.3 years. (For FY 2002, the comparable figures were $183,608 for 2.25 years.)

The NRI provided funds totaling $329,400 in partial support of 33 conferences in FY 2003. These conferences brought scientists together to identify research needs, provide an update on research information, and/or advance an area of research important to U.S. agriculture, food, forestry and the environment.

In FY 2003, the NRI provided funds totaling $12,902,148 in Agricultural Research Enhancement Awards. This support included Postdoctoral Fellowships, New Investigator Awards, and Strengthening Awards (see Table 3).

Crosscutting Areas

A number of research topics of major importance to USDA involve several research areas or programs. NRI support for these crosscutting program areas in FY 2003 is indicated in Table 4.
The data show the total amount of funding from all research areas for a specified research topic. For example, the Water Quality area includes projects from the Watershed

Processes and Water Resources Program as well as projects from other programs relevant to water quality such as Soils and Soil Biology. The Integrated Pest Management area includes projects funded from the programs on Biologically Based Pest Management, Entomology and Nematology, Biology of Plant-Microbe Associations, and Biology of Weedy and Invasive Plants.

Research Dimensions

As noted earlier, research programs can be examined from perspectives such as type of investigation (fundamental or mission-linked) and organization of research approach (single discipline or multi-disciplinary). These collaborations, where appropriate, may integrate the biological, physical, chemical, and social sciences. NRI funding in FY 2003 for these three categories is shown in Table 5.

Interagency Research

NRI National Program Leaders work closely with their research-funding counterparts in other federal agencies to avoid duplication and maximize interagency cooperation. An example of cooperation is seen in the research that NRI funds jointly with other federal agencies, including:

- The Interagency Metabolic Engineering Program, established in 1998 with the Department of Energy (DOE), the National Science Foundation (NSF), the Department of Commerce (DOC), and the Department of Defense (DOD), the Environmental Protection Agency (EPA), National Institute of Health (NIH/NIGMS), the National Aeronautics and Space Administration (NASA) and USDA. FY 2003 is the sixth year of this program. The NRI co-funded the award "Quantitating and Manipulating Seed Metabolic Networks." More information is available at the metabolic engineering website (*www.epa.gov/opptintr/metabolic/*)
- The USDA in partnership with NSF and DOE has provided supplemental FY 32003 funding to the U.S. Rice Genome Sequencing Project. The collaborators of U.S. Rice Genome Sequencing Project (USRGSP) have completed the sequence and analysis of rice chromosome 10 (Rice Chromosome 10 Sequencing Consortium, Science 300:1566-1569, 2003).
- The Microbial Genome Sequencing Project has been supported jointly by the USDA/CSREES and National Science Foundation (NSF) since FY 2001 building on a Microbial Genome Sequencing Program offered by the USDA/CSREES in FY 2000. In FY 32003, the USDA-CSREES / NSF Microbial Sequencing Project jointly supported the sequencing of 31 microorganisms including plant and animal pathogens and biological control agents which are important to agriculture, food, forestry and the environment.

Each interagency research program issues a single request for proposals, and representatives of the agencies work together to assemble a panel of scientific peers to identify the most meritorious proposals. From this group, representatives of each agency select proposals that are the most germane to the mission of that agency. Thus, the NRI is able to attract researchers from a wide applicant pool, to address areas of importance to

agriculture, food, forestry and the environment.

The National Research Initiative: Supporting the CSREES Mission

In FY 2003, the NRI funded 664 grants. This section provides a few examples of fundamental and mission-linked research targeted at problems important to the USDA mission, funded through the 39 panels, and related to the five broad outcomes outlined in CSREES' *Government Performance and Results Act Strategic Plan*.

Outcome 1: An agricultural production system that is highly competitive in the global economy

US Rice Genome Project. While the Human Genome Project has changed our perspectives of life and has initiated a revolution in medicine and diagnostics, the sequencing of the rice genome has created an equal revolution in plant biology and agriculture. Rice is a cereal and is closely related to agriculturally important crop plants including wheat, barley, corn, and sorghum. Since the rice genome is compact and is of significant agricultural importance world-wide, it has been the target of an international genome sequencing effort. The U.S. is a member of the International Rice genome Sequencing Project (IRGSP), and scientists at **The Institute for Genomic Research (TIGR), University of Arizona, Cold Spring Harbor Laboratory** and **Washington University** were funded to sequence portions of the rice genome. scientists haveFor more information see the US rice genome sequencing project website at: http://www.usricegenome.org

The collaborators of U.S. Rice Genome Sequencing Project (USRGSP) have completed the sequence and analysis of rice chromosome 10 (Rice Chromosome 10 Sequencing Consortium, *Science* 300:1566-1569, 2003).specific With respect to improvement of rice production, a number of disease resistance genes were present on this chromosome, and these genes provide a new set of candidate genes for breeders to improve current rice varieties. The information is useful in comparative genomic studies with other crop species. In a comparison with maize and sorghum, rice chromosome 10 is very similar at the genome level and will be valuable to understand the other cereal species. These data suggest that even partial genome sequence for other crop species may be leveraged using the complete rice genome. Thus, the rice is a model system for other crop species; the benefits of sequencing the rice genome are not limited to rice and will be seen in other crop species of significant economic importance in the U.S. such as wheat, barley, corn and sorghum.

Bovine Genome Sequencing Project (BGSP). Issues related to the health and food safety of agricultural cattle are of enormous concern to the public because of their importance in the human food chain and the agricultural economy. This project to elucidate the DNA sequence of the cow will advance biology, biotechnology and animal science, including improving food production, increasing the utility of the organism as an animal model for health and disease, and enabling comparison of the cow DNA sequence with the human genetic code. **Drs. R. A. Gibbs, G. M. Weinstock, M. L. Metzker, D.**

M. Muzny, L. V. Nazareth, D. L. Steffen, D. A. Wheeler, K. C. Worley of **Baylor College of Medicine** will generate a draft sequence of the genome of *Bos taurus*. The genome will be an invaluable resource for improving food production, basic research and comparisons to the human genome.

Genomics of pathogenic fungus Fusarium graminearum (Gibberella zeae). The fungus *Fusarium graminearum* has a dual negative impact as a plant pathogen. First, it causes head blight (scab) in both wheat and barley, a disease that resulted in a $3 billion loss to U.S. agriculture during epidemics in the 1990s. The *Fusarium* genome sequence is critical for a molecular understanding of how *Fusarium* infects plants, enabling the development of effective, specific fungicides and highly resistant plant strains. Second, the *Fusarium* fungus produces mycotoxins that pose a serious food safety hazard. For example, vomitoxin caused weight loss and feeding refusal in livestock; human's ingestion of *Fusarium*-contaminated grain results in nausea, vomiting, anorexia or convulsion. The genome sequence will help in understanding mycotoxin synthesis and/or counteract mycotoxin toxicity. Using a single strain chosen by the International *Gibberella zeae* Genomics Consortium, **Drs. B. Birren, H, C, Kistler, J. Xu and F. Trail** of **Whitehead Institute for Biomedical Research Center for Genomic Research** will determine the genomic DNA sequence of the fungal plant pathogen *Fusarium graminearum*.

Functional Roles of Maize Genes that Respond to Water deficit and their Relationships to Stress Tolerance in Early Kernel Development. Maintenance of crop productivity under harsh, unfavorable environmental conditions is an important problem for agriculture. In maize, water deficits during pollination and grain (kernel) formation cause severe losses in crop productivity. **Dr. Tim Setter** of **Cornell University** has been studying the biology of kernel set in water-stressed maize. Previous NRI-funded research from Dr. Setter's lab suggests that loss or failure of kernel set in response to water stress involves the plant hormone abscisic acid (ABA) and an inadequate sugar supply in growing tissues. In a proposal funded in 2003, Dr. Setter will continue his studies on the molecular basis for kernel set. Specifically, he will examine gene expression during water stress and recovery and analyze the role of regulatory and signaling factors, including abscisic acid and sugar levels, in this gene expression. The research integrates biochemical, molecular and whole plant analyses and will provide important insights into the biological and molecular mechanisms underlying kernel abortion under drought conditions. This information can lead to development of grain plants with improved performance during drought and to increased stability of grain yield under different environmental conditions.

Outcome 2: A safe and secure food and fiber system

Foot and Mouth Disease in North America Wildlife: Susceptibility, Transmission, Carrier/Shedder Potential And Mitigation Strategies. **Dr. M. D. Salman** of **Colorado State University** will gather basic data on the pathophysiology of Foot and Mouth disease (FMD) in elk, mule deer and pronghorn. In particular, they will determine: 1) susceptibility to FMD infection, 2) potential for intra-species transmission and transmission of the infection to cattle, 3). potential of wildlife species to act as long term

carriers or shedders of FMD, and 4) ability of conventional laboratory tests to detect FMD in wildlife species. Dr. Salman will incorporate the data collected through this research to construct a simulation model of the spread of FMD among and between wild and domestic species, applying different scenarios and given implementation of different mitigation strategies, and to evaluate the efficacy and cost-effectiveness of these strategies. The findings from the research will assess the animal health decision makers in their preparedness plan for controlling the introduction and the spread of FMD in the U.S. The study is part of our national active plan to obtain sufficient knowledge about the disease in these species.

Development of a Novel Paradigm for the Real-Time Monitoring of Bacterial Pathogenicity in Swine. There are 2 million non-typhoid salmonellosis cases in the U.S. per year costing on average $1.4 billion. *Salmonella* infection is a ubiquitous problem in the livestock industry, and the bulk of *Salmonella* infections in humans originate from food of animal origin. Recent evidence has shown that on-farm *Salmonella* prevalence in swine may be as low as 5.3%, yet after transport and holding at the abattoir, prevalence of the same herds rose to 39.9%. *Salmonella* bacteria exposure is of concern to swine health pre-harvest, and is a possible human health concern post-harvest. **Drs. Scott Willard and P. L. Ryan** at **Mississippi State University** will use novel imaging technologies (biophotonics) to learn more about how *Salmonella* bacteria progress through swine and the effects of management stress on pathogenicity.

Characterization of Multiple Antibiotic Resistance Among Enterohemorrhagic E. coli. During the past decade, bacteria that cause human diseases have developed resistance to many of the antibiotics commonly used for treatment. Excessive use for treating animal diseases , and subtherapeutic applications of antibiotics for disease prevention and growth promotion in animal husbandry, may have played a significant role in accelerating the emergence of antibiotic-resistant bacteria. Such organisms can then be transferred from animals to humans through the food chain. Enterohemorrhagic *E. coli* (EHEC) have been a significant cause of foodborne illness in the U.S. These pathogens also have been acquiring resistance phenotypes. In order to control the emergence and spread of antibiotic resistance, it is necessary to better understand the trend of resistance and the mechanisms that lead to antibiotic resistance in foodborne pathogens. In this research, **Drs. Jianghong Meng, D. White and C. DebRoy** at the **University of Maryland** will generate baseline data on the trend of antibiotic resistance in EHEC which will help elucidating the role that the use of antibiotics in food animals plays in the development of antibiotic resistance in foodborne pathogens.

<u>Outcome 3: A healthy, well-nourished population</u>

Randomized, Controlled Community Intervention to Reduce the Risk of Type 2 Diabetes in Overweight African American Children. The prevalence of pediatric type 2 diabetes has risen at an unprecedented rate. Urgently needed to address this public health crisis are prevention strategies that target high risk children, can be easily replicated, are sustainable, and can be used to inform food aid programs, and community and school organizations traditionally involved in the health and welfare of children. The goal is to

reduce the risk of type 2 diabetes in overweight 9- to 10-year-old African American children through a community-based program that includes research, extension and education components. **Drs. S.E. Fleming and J.P. Ikeda** at the **University of California, Berkeley** intend to recruit and randomly assign 140 children to either an intervention or control group. Two phases, a 2-week summer camp followed by 2-years of monthly reinforcement activities, will target healthy eating, physical activity promotion, and self-esteem and self-efficacy building behaviors in order to reduce type 2 diabetes risk irrespective of weight loss. The effectiveness of the program will be assessed 3 months after the completion of the summer camp and after 1 and 2 years of intervention. Risk of type 2 diabetes will be assessed by measuring hematological variables (blood glucose and insulin concentrations, insulin sensitivity and clearance, hemoglobin A1C, free fatty acids); consumption of fruits, vegetables, whole grains, low-fat dairy and sweetened beverages; physical activity and fitness; psychosocial variables (self-esteem and self-efficacy); and body mass index and body fatness.

Fish Skins as a Novel Source of Blood Anticoagulant Pharmaceuticals: Conversion of Waste to an Economic Value-Added Product for Medical Use. Heparin is an invaluable drug used extensively to prevent blood clotting in patients experiencing a heart attack or undergoing surgery. In addition, life-saving medical procedures such as heart bypass, renal dialysis and coronary angioplasty would be much more difficult, if not impossible, to perform in the absence of heparin. Heparin consists of a mixture of sugar chains that differ in length and in various other chemical properties. A number of these chemical properties are necessary for heparin to produce an anticoagulant (blood thinning) effect. Heparin that is used clinically is extracted from the intestinal tissues of hogs or lung tissue from cattle. Heparin has also been demonstrated in a variety of marine organisms. Heparins derived from various tissues exhibit different structural features that impact biologic activity. Concerns about the spread of disease have curtailed the use of tissues from cattle as a source of heparin. Pilot data has shown that heparin or a heparin-like substance can be extracted from the skins of several species of fish. **Drs. W. P. Jeske, E. Coyne, J. M. Walenga and J. Fareed** of **Loyola University** will study the use of fish species to extract heparin, characterize the anticoagulant/antiprotease activity of the extracted heparin, and demonstrate the *in vivo* potency of the extracted heparin at inhibiting blood clot formation in a standardized animal model.

Outcome 4: Greater harmony between agricultural and the environment

Ecosystems Responses to Experimental Warming and More Extreme Precipitation Patterns. Climatic variability, particularly in rainfall, both between years and within the growing season is characteristic of all grasslands. Climate change predictions for temperate grassland regions include increased variability in the timing of precipitation events (more extreme rainfall patterns) and warmer temperatures. The tallgrass prairies in Kansas support a livestock grazing industry second only to Texas in stocking rate. **Drs. Alan Knapp and John Blair** of **Kansas State University** will combine experimental manipulations of precipitation and temperature in tallgrass prairie to assess aboveground plant/ecosystem responses. Precipitation will be manipulated by altering the timing of precipitation events by increasing dry periods between storms by 50% and

combining numerous small rain events into large events. Temperatures will be increased with infrared lamps. These alterations will simulate potential climate changes, specifically more extreme rainfall patterns and warming air temperature. Responses in plant stress, plant community structure including susceptibility to invasive species and aboveground productivity will provide predictive insights into future grassland/climate interactions.
Grasslands provide significant economic benefits to Kansas and any impacts of climate change will directly affect the livestock industry in Kansas. The researchers hope to better understand the consequences of potential changes in climate, particularly rainfall and temperature regimes for grasslands.

Heterogeneity on Rangelands: Effects on Biodiversity and Productivity. Rangelands are spatially and temporally heterogeneous in that they are highly variable in vegetation composition and structure. Traditional rangeland management promotes uniform disturbances across the landscape reducing heterogeneity and potentially biodiversity. **Drs. Samuel Fuhlendorf, D. M. Engle, Craig Davis and David Leslie Jr.** of **Oklahoma State University** propose an alternative paradigm that has potential to promote heterogeneity and biodiversity on rangelands while maintaining livestock production. In this research they test a new paradigm of rangeland management that proposes to simultaneously enhance biological diversity and maintain livestock production on rangelands with a long history of grazing by large herbivores. The overall goal is to evaluate the importance of heterogeneity of mixed and tallgrass prairie by burning patches within pastures and allowing free selection of livestock between burned and unburned patches. Specifically, the researchers will 1) evaluate the heterogeneity of botanical composition, diversity, and habitat structure; 2) monitor the response of grassland birds; and 3) monitor livestock behavior, diet and performance. They have initiated extension programs through range extension specialists and local extension educators as well as specialists through the Natural Resources Conservation Service.

Carbon Sequestration and Carbon and Nitrogen Cycling Processes in Organic Agricultural Ecosystems. Agricultural soils may help decrease the threat of global warming by sequestering carbon (C) in soil organic matter. There is some evidence that organic farming may store more C than conventional management. However, organic agriculture has received very little scientific study in the U.S. **Drs. Deborah Stinner, Bejamin Stinner and Patick Hatcher** of **Ohio State University** will assess Carbon sequestration and Carbon and Nitrogen cycling in organic agricultural ecosystems and to evaluate implications on a landscape scale. To build basic understanding of short and long-term ecological changes in land that is transitioned from conventional to organic production a Field Crop Transitional Experiment was established in spring 2000. Two cropping systems (a conventional corn-soybean and organic corn-soybean-small grain-hay) are compared. The research findings thus far are suggesting that organic farming can be a viable management system for carbon sequestration and have important implications to yields as well as overall patterns of carbon and nitrogen cycling.

Wood Pulp/Lyocell Fibrous Products. Cellulose-based lyocell fiber is a relatively new fiber having several outstanding characteristics. Being a regenerated cellulose, it is based

on renewable sources, is fully biodegradable, it has good mechanical properties, it can be formed into a variety of shapes and cross-sections, and it is manufactured by an environmentally friendly procedure. Furthermore, lyocell fibrillation characteristic can be used to produce ultra-soft "peach skin" textures for the manufacture of luxurious fashion apparel and many other scientific and technical application products. Currently, lyocell fibers are manufactured by the wet spinning process, which consists in precipitation of cellulose from a solution (lyocell) prepared from dissolving pulp. Market penetration of this new fiber is still limited by the high cost of the dissolving pulp (a high purity pulp used for chemical processing), as compared with the cheaper paper pulp grades. **Drs. J. R. Collier, S. Petrovan and T. G. Trials** at the **University of Tennessee** will investigate the processes of preparing lyocell solutions from lower cost wood pulp grades and manufacturing fiber and non-woven mat products by wet spinning and solution blowing.

Outcome 5: Enhanced opportunities for farmers, ranchers, and rural people and communities

***Maximizing Protection of Ecological, Agricultural, and Community Values at the Rural-Urban Fringe*.** Rapid land use change and loss of agricultural, wildlife habitat, and open space is causing increased conflict at the rural-urban fringe. Although we have a general understanding of the extent and trends of these changes, there is limited understanding of the protected areas that exist on private land, the resource values that are protected, and the context provided by adjacent land use and public lands. **Drs. David Theobal and Stephen Weiler** of **Colorado State University** will examine the land use patterns that are emerging at the rural-urban fringe in the Rocky Mountain West to determine how these patterns affect the protection of ecological, agricultural, and community resources in rural areas and how emerging land use tools (especially cluster development) could be used to maximize protection of rural resource values. Using principles informed by landscape ecology and contingent valuation methods, they will develop empirical estimates of the relationships between land use pattern and ecological and economic resource values within a spatially-explicit framework. These estimates will form the basis of guidelines that can inform local government land use decision processes, rural land owners themselves, and agency and non-profit organizations about which approaches, practices, and policies maximize the protection of rural land resources and the ecological, agricultural and community benefits.

***Local Housing Decision and Economic Vitality of Rural Communities*.** Although a sizable number of local housing decisions are made each year in rural communities, little is known about the way that they affect, or their contribution to, rural vitality. Without this knowledge, it is difficult to delineate coherent development strategies. **Dr. Christine Cook and Sue Crull** of **Iowa State University** will identify the kinds of local housing decisions and activities that have occurred in rural communities in counties with high and low vitality and to analyze the effect of local housing decisions and activities on the vitality of rural communities. Their hypothesis is that local housing decisions and activities affect the vitality of rural communities by promoting or failing to promote strategies that improve local housing situations for current residents and that draw

potential new workers and retirees. The results of the study will increase the knowledge of the housing delivery process, one of the important forces influencing rural development. By identifying how and the extent to which housing affects rural vitality, our research findings will impact public policy and the vitality of rural communities in the future.

Anti-Cancer Drugs: Development of Podophyllum peltatum L. as an Alternative Crop for Small Farmers. Podophyllotoxin is the starting material for the semi-synthesis of the anticancer drugs etoposide, teniposide and etopophos which are used to treat lung and testicular cancers as well as certain leukemias. Currently the commercial source of podophyllotoxin is *Podophyllum emodi*, an endangered species from the Himalayas**. Drs. Rita Moraes and Ikhlas Khan and Charles Burandt Jr**. at the **University of Mississippi** are investigating the use of the American Mayapple (*Podophyllum. peltatum L.*) as an alternative source of this important pharmaceutical compound. The long term goal is to establish P. *peltatum* as a cash crop for U.S. farmers and ensure a ready supply of the drug precursor while allowing the preservation of the threatened *P. emodi.* The researchers patented a new extraction method for podophyllotoxin and identified high-yielding podophyllotoxin accessions. When compared to alternative sources of podophyllotoxin, such as Juniperus, Teucrium, and Cedar, leaf blades of mayapple had the highest podophyllotoxin concentration. They established *P. peltatum* as a rich, renewable source of podophyllotoxin, yielding more than 5% of a dry weight basis (comparable to *P. emodi*). This crop could provide a high value, niche market for small farmers in rural communities.

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President's Early Career Award for Scientists and Engineers (PECASE)

Dr. Timothy Link of the **University of Idaho** was the FY 2003 recipient of the Presidential Early Career Award for Scientists and Engineers. He was nominated by the NRI for his current and potential future excellence of his research. He received funding for his proposal entitled *Impact of Forest Treatments and Climate Change on Hydrologic Regimes* and was recognized by the review panel as addressing a critical need for better understanding and predictability of the impacts of climate change and forest management practices on hydrologic processes in our watersheds in Western seasonal and transient snow zones, a major region that is highly susceptible to extremes in water supply and precipitation patterns. Results of his work will address the national priorities related to climate change, resource management, and drought.

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From Discovery to Practice:
A Success Story from CSREES Competitive Programs

The National Research Initiative supports a wide array of fundamental scientific research. Over time the scientific findings produced serve as a starting point that can lead to concrete products that support and advance U.S. agriculture. Listed below is a case study on how this process works.

In the 1970s, the world suffered its first energy crisis. As a result, governments worldwide, including the US Government, strongly encouraged and supported the development of alternative fuels for transportation, particularly a renewable liquid fuel that could be produced from domestically available renewable resources. Ethanol has been proven to be a desirable renewable liquid fuel for transportation. Ethanol can be produced from cellulosic biomass (corn stover, rice straw, wood, grasses, waste papers, etc.), which is abundantly available throughout the world – especially in our country. These feedstocks are also inexpensive and some of them exist as municipal or industrial wastes. Converting such wastes to ethanol also helps to solve waste disposal problems.

In response to this urgent need, Purdue University established its Laboratory of Renewable Resources Engineering (LORRE) to focus on the development of ethanol fuel from cellulosic biomass. It was known that more than 70% of these resources could be converted to sugars. Presumably these sugars would be fermented to ethanol by microorganisms, particularly by the *Saccharomyces* yeast. The *Saccharomyces* yeast, also known as baker's yeast, is the most effective microorganism for the fermentation of glucose and related hexose (six carbon) sugars to ethanol. It is the only microorganism that has been used for large-scale ethanol production.

However, it was found that the *Saccharomyces* yeast was unable to ferment the sugar known as "xylose" (a five carbon pentose sugar), the second major sugar (next only to glucose) present in most types of cellulosic biomass. Unfortunately, there were also no other known naturally occurring microorganisms that could effectively convert both glucose and xylose to ethanol.

At the end of the 1970s, there was a worldwide concerted effort to genetically engineer the *Saccharomyces* yeast to ferment xylose to ethanol using recombinant DNA techniques. By then, LORRE had already established a great reputation in developing various technologies required for the conversion of cellulosic biomass to ethanol. LORRE naturally wanted to pursue the development of recombinant yeast to ferment xylose. This provided an opportunity for Nancy Ho to be involved in the development of ethanol fuel from cellulosic biomass.

Due to her expertise in recombinant DNA technology, Dr. Ho was sought by LORRE to help shape their strategy for developing a recombinant microorganism to ferment biomass. She sensed the importance of the project and joined LORRE to lead the study.

In the early 1980s, there were about ten groups independently pursuing the task of genetically engineering the *Saccharomyces* yeast to ferment xylose and more than half of the groups were in the US. Not only was her group the smallest, but Dr. Ho also had to obtain most of her own funding – through grant applications to the Federal Government Agencies – to support her group's research.

In short, after encountering serious setbacks in the earliest attempts to engineer the yeast, most other US groups had given up on this pursuit by the middle 1980s. Some experts concluded that it might be impossible to engineer the *Saccharomyces* yeast to ferment xylose. By the end of the 1980s, there were only four groups – Dr. Ho's group at Purdue University, two groups in Europe, and one group in Japan – still pursuing this important project. Dr. Ho continued her work, because she felt that according to her analysis and design, the *Saccharomyces* yeast could be genetically engineered to ferment xylose. She also wanted to exhaust all possibilities before giving up because the *Saccharomyces* yeast is the safest and most effective microorganism for the conversion of sugars to ethanol. Furthermore, she felt very strongly that cellulosic biomass should be converted to ethanol or other chemicals. Despite encountering various obstacles, Dr. Ho continued this project with great determination. In the long run, her persistence paid off.

In 1993, Dr. Ho's Group at Purdue succeeded in the development of the world's first genetically engineered yeast that could effectively ferment xylose AND co-ferment both glucose and xylose to ethanol. This was accomplished by cloning three genes, **XR**, **XD** and **XK,** which are crucial for converting xylose to ethanol, into a small circular DNA molecule known as a plasmid by recombinant DNA techniques. The recombinant plasmid was then transferred into the host yeast.

This is a long-term project. Having made the Saccharomyces yeast capable of co-fermenting the major sugars, glucose and xylose, from cellulosic biomass, Dr. Ho's group started to optimize the recombinant yeast for industrial ethanol production. Furthermore, Dr. Ho foresaw that the recombinant yeast could also be made to convert sugars from cellulosic biomass to other important industrial chemicals. Yeast can make cellulosic biomass a true replacement for petroleum to provide the world with fuels and chemicals. In addition, the fuels and chemicals from cellulosic biomass are renewable as well as cleaner and environmentally friendlier. Thus, since 1993 to the present, her group has continued to improve the *Saccharomyces* yeast to more cost effectively produce cellulosic ethanol on an industrial scale and to produce other important industrial chemicals from cellulosic sugars – such as lactic acid.

This past April (21 April, 2004), Iogen Corporation began to produce the world's first cellulosic ethanol fuel from wheat straw, using Dr. Ho's yeast, for commercial use (Iogen news release),(Business Week), (Purdue news release), (ASM news, Oct 2004). Iogen also reported that only Dr. Ho's yeast is suitable to produce ethanol from these resources on an industrial scale.

The USDA Competitive Grants Office recognized Dr. Ho's innovation and her ability in solving this problem and supported her research between 1981 and 1991. In 2003, the USDA

Competitive Grant Office again recognized Dr. Ho's dedication and innovative approaches in continuing to improve the yeast and awarded her another grant.

Dr. Ho firmly believes that without the USDA's unwavering support the first ten years, it would have been difficult for her to develop her yeast. Since the early 1980s, Dr. Ho's work has been published in various leading scientific journals, such as Enzyme and Microbial technology (three publications), Applied And Environmental Microbiology (one publication), ACS Symposium Series (one invited publication), Advances in Biochemical Engineering/Biotechnology series (one invited publication), World Journal of Microbiology and Biotechnology (one publication), and the Symposium series on Biotechnology for Fuels and chemicals (numerous presentations and publications), etc. In addition, Dr. Ho has submitted two patent applications from this work.

Table 1. Characteristics of NRI Peer Panels, FY 2003

Geographic Region	Number	Percentage
North Central[1]	134	28
Northeast[2]	107	22
South[3]	128	27
West[4]	107	22
Type of Institution		
Land-Grant	293	61
Public/Private	75	16
Federal	65	14
Industry/Other	43	9
Type of Position		
Assistant Professor	81	17
Associate Professor	117	25
Professor	164	35
Federal	66	14
Industry	31	7
Other	16	3
Gender/Minority Representation[5]		
Non-minority Males	258	54
Non-minority Females	129	27
Minority Males	59	12
Minority Females	31	7

[1] Northeast region includes the following states plus DC: CT, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT, WV

[2] North Central region includes the following states: IA, IN, IL, KS, MI, MO, MN, ND, NE, OH, SD, WI

[3] Southern region includes the following states: AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA

[4] Western region includes the following states: AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY

[5] Minorities include Asians, African Americans, Hispanics, Pacific Islanders, and Native Americans

Table 2. NRI Funding Allocations[1], FY 2003

Research Area/Program	Number of Grants Awarded	Total Dollars Awarded
Natural Resources & Environment		
Plant and Environmental Adaptation	21	3,343,932.00
Watershed Processes and Water Resources	22	4,410,615.00
Soils and Soil Biology	30	4,989,225.00
Managed Ecosystems	19	4,013,692.00
Air Quality	13	5,100,000.00
Total Natural Resources and Environment	**105**	**21,857,464.00**
Nutition, Food Safety, & Health		
Improving Human Nutrition for Optimal Health	29	4,304,806.00
Food Safety	27	5,413,245.00
Epidemiological Approaches to Food Safety	6	5,484,233.00
Human Nutrition and Obesity	12	8,200,000.00
Total: Nutrition, Food Safety, & Health	**74**	**23,402,284.00**
Animals		
Aminal Reproduction	20	3,817,548.00
Animal Protection	53	10,745,048.00
Animal Genome	16	3,842,546.00
Animal Genome Reagent & Tool Development	3	2,090,892.00
Animal Growth and Nutrient Utilization	30	4,659,738.00
Total: Animals	**122**	**25,155,772.00**
Biology and Management of Pest Beneficial Organisms		
Itegrative Biology of Arthopodes & Nematodes	36	5,560,180.00
Biology of Plant-Microbe Associations	30	5,463,081.00
Biologically Based Pest Management	17	3,067,356.00
Biology of Weedy and Invasive Plants	22	3,644,096.00
Total: Biology and Management of Pest Beneficial Organisms	**105**	**17,734,713.00**
Plants		
Plant Genome	22	4,603,082.00
Genetic Processes & Mechanisms of Crop Plants	26	4,382,932.00
Developmental Processes of Crop Plants	33	4,589,442.00
Biochemistry of Plant and Plant Symbionts	26	4,356,675.00
Application of Plant Genomics Coordinated Ag. Project (CAP)	1	1,000,000.00
Total: Plants	**108**	**18,932,131.00**

Markets, Trade, & Rural Development		
Markets and Trade	14	1,998,762.00
Rural Development	15	1,961,365.00
Total: Markets, Trade, & Rural Development	**29**	**3,960,127.00**
Enhancing Value and Use of Agricultural and Forest Products		
Biobased Products & Bioenergy Production Research	18	2,785,648.00
Improving Food Quality	37	6,389,298.00
Improved Utilization of Wood and Wood Fiber	18	1,954,019.00
Total: Enhancing Value and Use of Agricultural and Forest Products	**73**	**11,128,965.00**
Inter-Agency Programs		
Metabolic Engineering Program	2	300,000.00
U.S. Rice Genome Project	4	1,488,082.00
Microbial Genome Sequencing Project	11	5,328,000.00
Bovine Genome Sequencing Program	1	4,790,034.00
National Training Program for Agricultural Homeland Security	2	500,000.00
Functional Genomes of Agriculturally Important Organisms	10	8,095,351.00
Nanoscale Science and Engineering	5	915,000.00
Geospatial Extension Specialist	6	980,769.00
Carbon Cycle Science	2	1,339,099.00
Animal and Plant Biosecurity	8	7,600,000.00
Total: Inter-Agency Programs	**51**	**31,336,335.00**
Grand Total	**667**	**153,507,791.00**

[1] The content of this table varies from tables provided in documents supporting the President's budget to Congress each year in that these data represent all awards made in FY 2003 regardless of the year funds were appropriated. Previous year funds may include some carried over from the proceeding year to achieve flexibility in proposal due dates and small unused amounts returned from awardees as grants expire.

Table 3. Agricultural Research Enhancement Awards, FY 2003

Type of Award	Number of Grants	Total Dollars Awarded
Postdoctoral Fellowships	15	1,055,705.44
New Investigator Awards	12	1,452,778.61
Strengthening Awards		
Research Career Enhancement Awards	6	478,782.00
Equipment Grants	34	782,338.20
Seed Grants	38	2,586,160.00
Standard Strengthening Research Projects	38	5,641,339.00
Total	**143**	**11,997,103.25**

Table 4. Crosscutting Program Areas, FY 2003

Research Topic	Number of Grants	Total Dollars Awarded
Plant Genome	38	$9,063,082
Forest Biology	34	6,106,536
Global Change	52	8,726,103
Sustainable Agriculture	96	16,504,809
Animal Genome*	28	13,323,368
Animal Health	89	26,052,462
Water Quality	33	6,663,089
Food Safety	64	15,451,963
Integrated Pest Management	1	125,000

***Includes Bovine Genome**

Table 5. Dimensions of NRI Research, FY 2003

Dimension	Amount of Support	Percent
Fundamental	$95,455,755	61
Mission-linked	62,015,847	39
Multi-disciplinary	78,992,236	50
Single discipline	79,367,095	50

Appendix

National Research Initiative Competitive Grants Program: Points of Contact

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